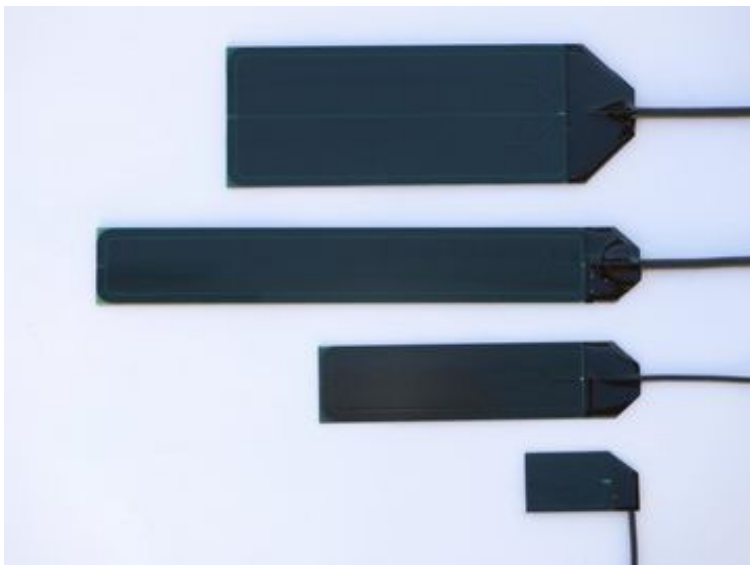


Air Gap Sensor

AGS

Installation and user manual



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THIS INSTRUCTION MANUAL SHOULD BE READ CAREFULLY AND THE SAFETY INSTRUCTIONS OBSERVED BEFORE INSTALLING, CALIBRATING OR USING THE EQUIPMENT DESCRIBED HEREIN.

- Installation and maintenance must be performed by qualified personnel familiar with the construction, operation, and hazards involved with the equipment.
- Installation and maintenance must be performed with the control out of operation and disconnected from all sources of power
- Care should be taken when servicing electrostatic sensitive components. The manufacturer's recommendations for these components should be followed.
- Ventilation passages should be kept open.
- The means employed for grounding or insulating the equipment from ground should be checked to assure its integrity.
- Care must be taken to avoid damaging any delicate components and to avoid displacing dust, dirt, or debris in a way that permits it to enter or settle into parts of the control equipment.
- Enclosures should be inspected for evidence of deterioration. Accumulated dust and dirt should be removed from the top of the enclosures before opening doors or removing covers.

1. Overview

High accuracy, non contact, capacitive type distance measuring sensor for measuring air-gap in air-cooled generators and electric motors

Low profile sensor probe with triaxial cable, preamplifier and shielded cable

Edge mount type for wind generators with very small air gap

High stability carbon particle semiconductive electrode made from glass epoxy fiber (FR4)

DC/DC insulated power supply

Optocoupler insulated output, 0...20 mA / 0...10V or 4...20mA / 2...10V

Wide operating temperature range with +/-3% accuracy (Full Scale Deflection):

- Sensor probe: -20...140°C,
- Signal Conditioner: -20...50°C

Immune to magnetic fields, dust and oil vapours, EMI, RFI

2. Application

Capacitive type distance measuring sensor for air-cooled generators and electrical motors.
High sensitivity, high resolution (up to 50 microns with oversampling).
Measuring of air-gap, rotor vibrations, rotor symmetry, power angle...

CAUTION: AGS is not certified for and shall not be installed in hydrogen-cooled alternators.

2.1. AGS selection table

In order to ensure **15% measurement headroom** please select Air Gap Sensor according to **the true air gap range** per the following formula:

Lower air gap range=Adhesive+sensor thickness+nonlinear meas.range+20%(FSD)-Error%(FSD)
Higher air gap range=Adhesive+sensor thickness+80%(FSD)+Error%(FSD)

Sensor type	AGS-4S	AGS-7,5S	AGS-13	AGS-25	AGS-50
Linear measuring distance (mm)	0,8...4	1,5... 7,5	2,6...13	5...25	10...50
Recommended for true air gap range (mm)	2,4...4,2	4...7,4	7...13	13...24	22...47
Linear output % (FSD)	17...83	17...83	17...83	17...83	15...85

Table 1. Linear measuring distance from the sensor surface vs. true air gap
(other ranges available per request)

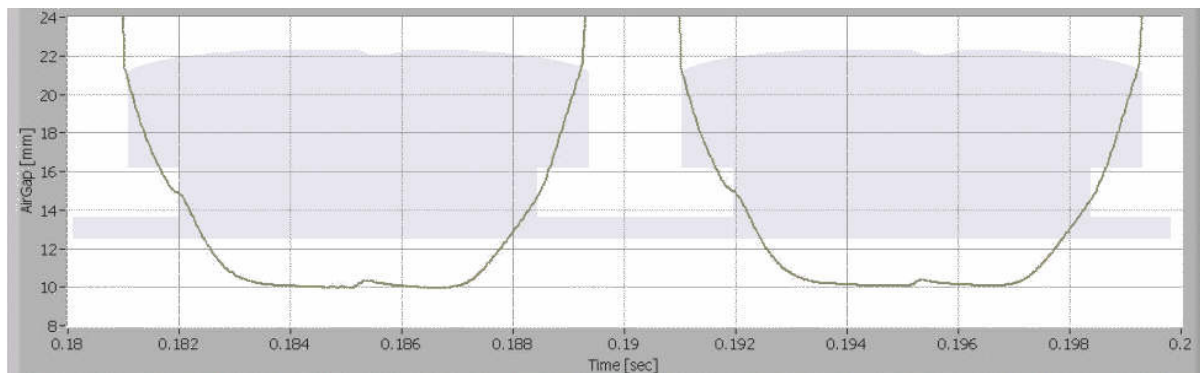


Figure 1: Image of AGS output signal, zoom of two poles only

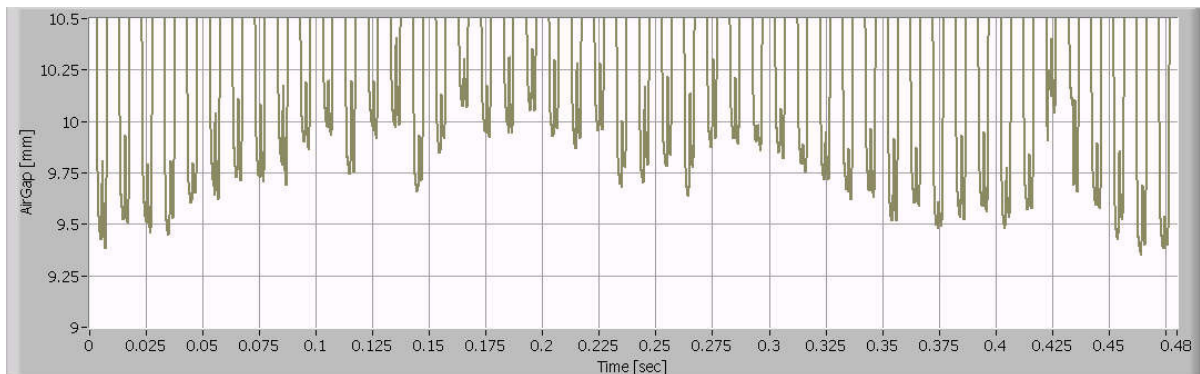


Figure 2: AGS output signal (one rotation)

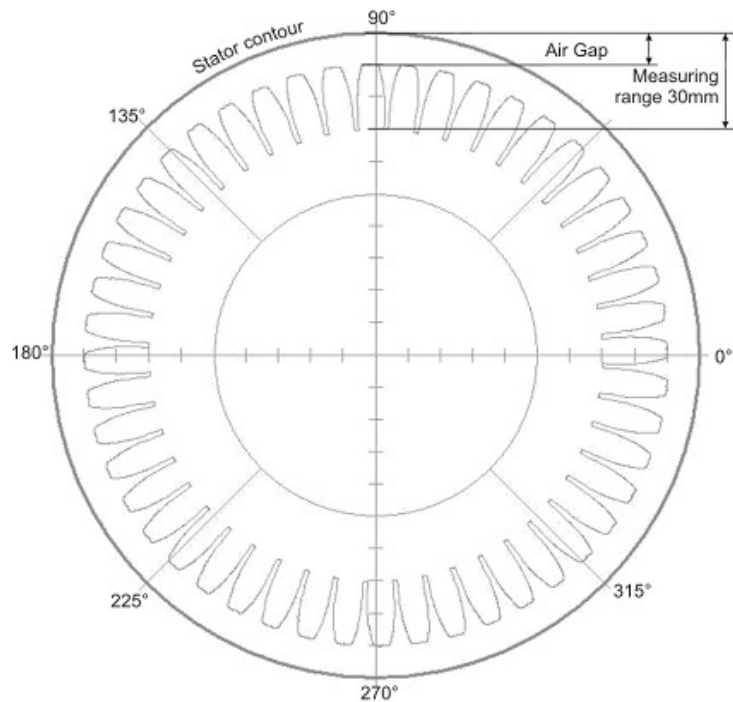


Figure 3: Image of AGS output signal, polar data

3. Technical specifications

	AGS-4S	AGS-7,5S	AGS-13	AGS-25	AGS-50
Measuring range (mm) (from sensor surface)	0...4	0...7,5	0...13	0...25	0...50
Linear measuring range (mm) (from sensor surface)	0,8...4	1,5...7,5	2,6...13	5...25	10...50
Recommended true air gap (mm)	2,4...4,2	4...7,4	7...13	13...24	22...47
Linearity FSD (25°C)	+/-1,5%	+/-1,5%	+/-1,5%	+/-1,5%	+/-3%
Linearity FSD (0...50/80/125°C) (1)	+/-3%				+/-5%
Linearity FSD (-20...50/80/140°C) (2)	+/-3%				+/-5%
Output noise	0,5%				
Output pole profile	0...20mA, (0mA=0mm), or 4...20mA (4mA=0mm) with 500 Ohm termination resistor 0...10V (2...10V), opto-insulated				
Sensitivity 0...20mA output	5mA/mm	2,667mA/mm	1,539mA/mm	0,8mA/mm	0,4mA/mm
Sensitivity 0...10V output	2,5V/mm	1,334V/mm	0,769V/mm	0,4V/mm	0,2V/mm
Sensitivity 4...20mA output	4mA/mm	2,134mA/mm	1,231mA/mm	0,64mA/mm	0,32mA/mm
Sensitivity 2...10V output	2V/mm	1,067V/mm	0,615V/mm	0,32V/mm	0,16V/mm
Typical frequency response	0...1000Hz, (-3dB) other bandwidth optional				
Magnetic flux density withstand	+/-1,8 Tesla				
Operating temp. (AGS probe)	-20...140°C				
Operating temp. (AGS preamp.)	-20...80°C				
Operating temp. (AGS sig.conditioner)	-20...50°C				
Storage temperature	-20...80°C				
Power input	+24Vdc, ±10%, 0,15A max.				
Warm-up time	20...30 min.				
Relative humidity	95% non condensing				
Vibration	IEC 68 2.27, 5 g peak, 10 Hz to 150 Hz				
Shock	IEC 68 2.27, 15 g peak, 11ms				
EMC	Sensor probe withstands 1,8 Tesla, 50/60 Hz magnetic field				
Probe immunity	magnetic fields, dust and oil vapours, without degradation of material				
AGSP probe dimension (mm)	51x25x0,8	68x29x1,1	112x29x1,7	232x32x3,2	175x60x4,1
AGSP cable length (m)	10				
AGSC sig. conditioner dimension (mm)	220 x 120 x 80 w/o cable inlets				
AGSC sig. conditioner protection class	IP66				
Weight AGS probe + cable	6g + 230g	10g + 230g	15g + 230g	50g + 250g	100g + 250g
Weight AGSC signal conditioner	1500g				

(1) AGSC (signal conditioner) at 50°C, AGS (preamp.) at 80°C, AGS (probe) at 125°C

(2) AGSC (signal conditioner) at 50°C, AGS (preamp.) at 80°C, AGS (probe) at 140°C

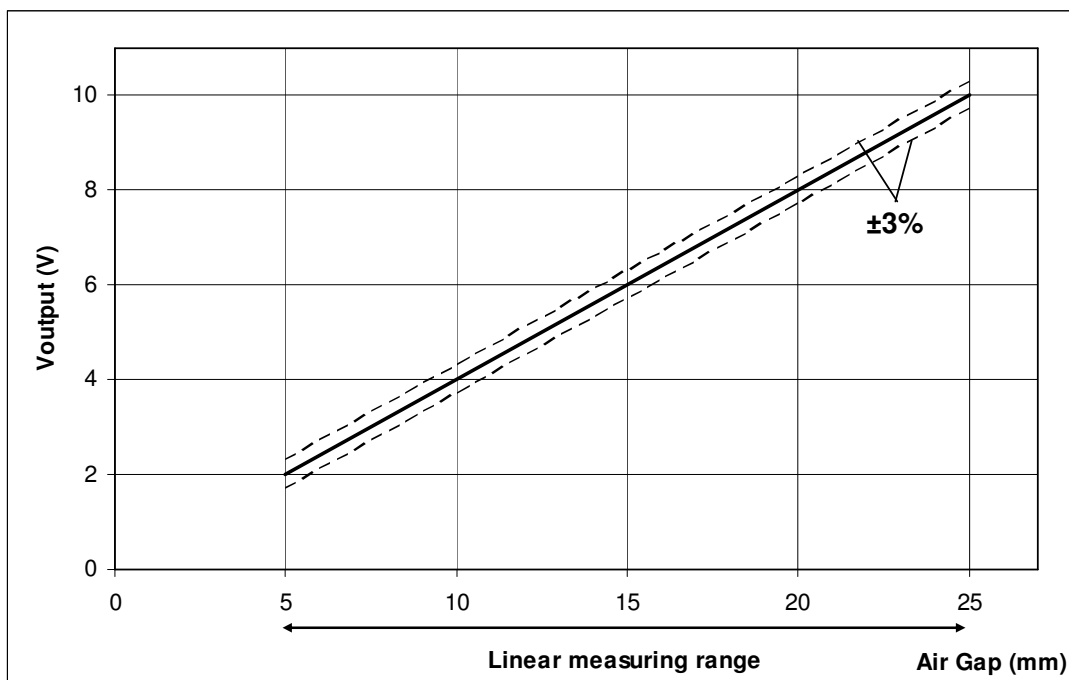


Figure 4. AGS - Linearity Full Scale Deflection (FSD) definition

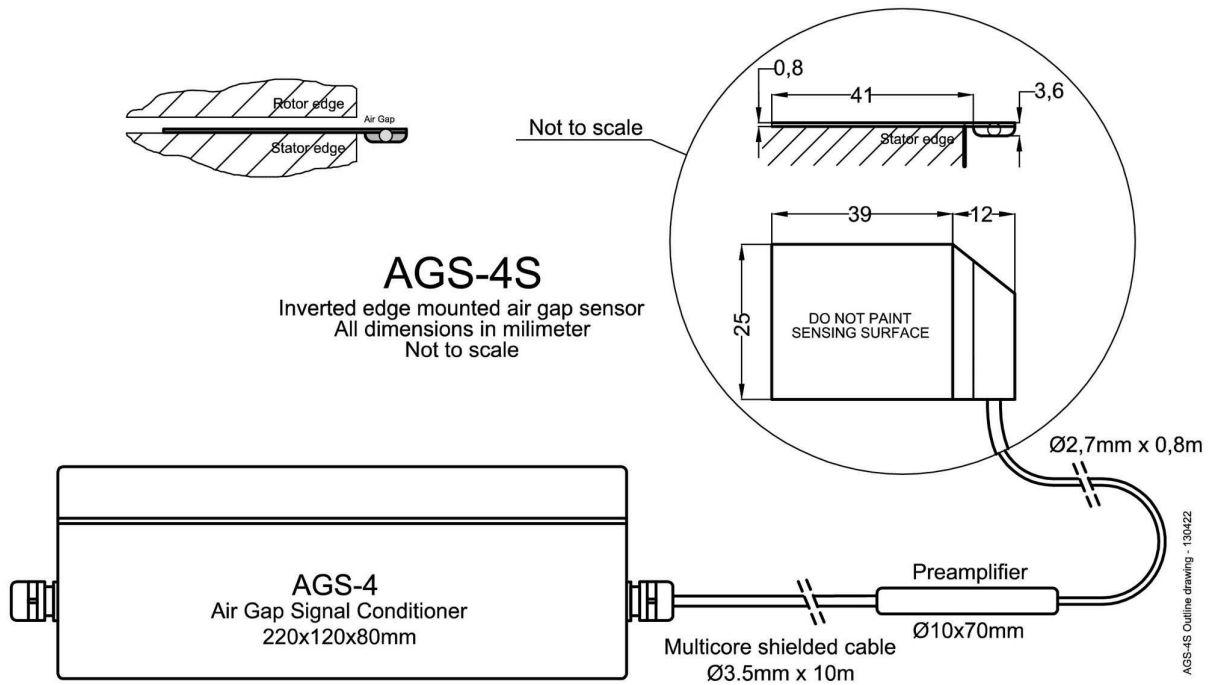


Figure 5. AGS-4S outline drawing

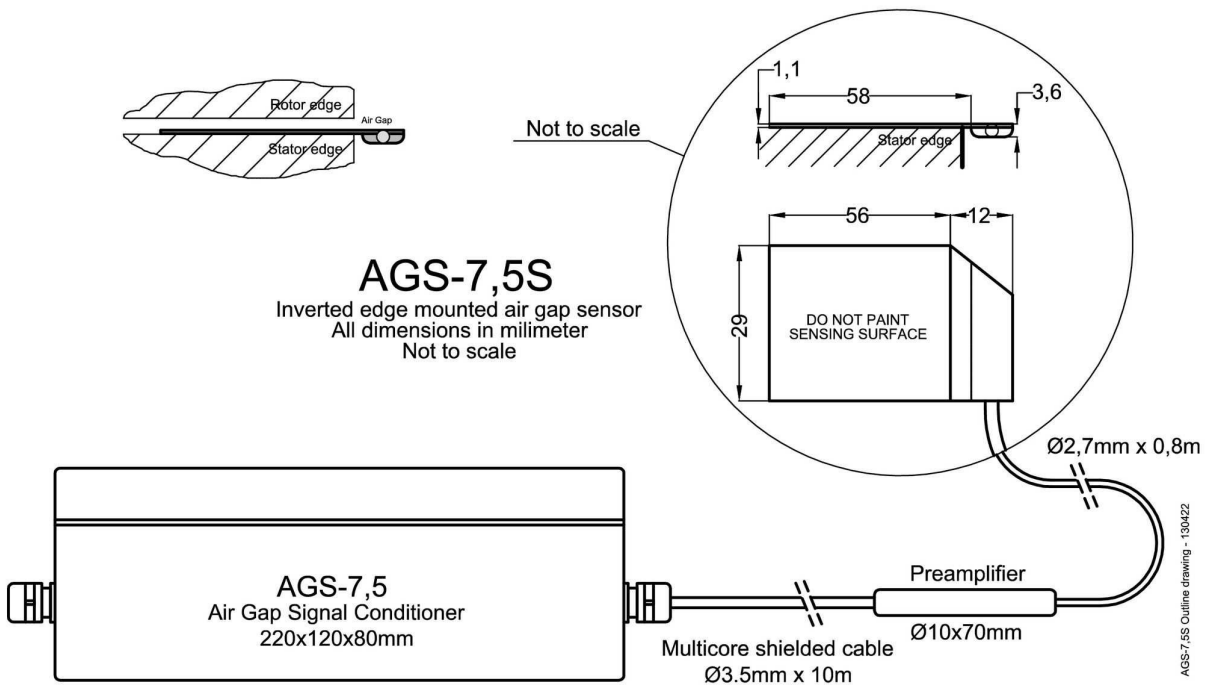


Figure 6. AGS-7,5S outline drawing

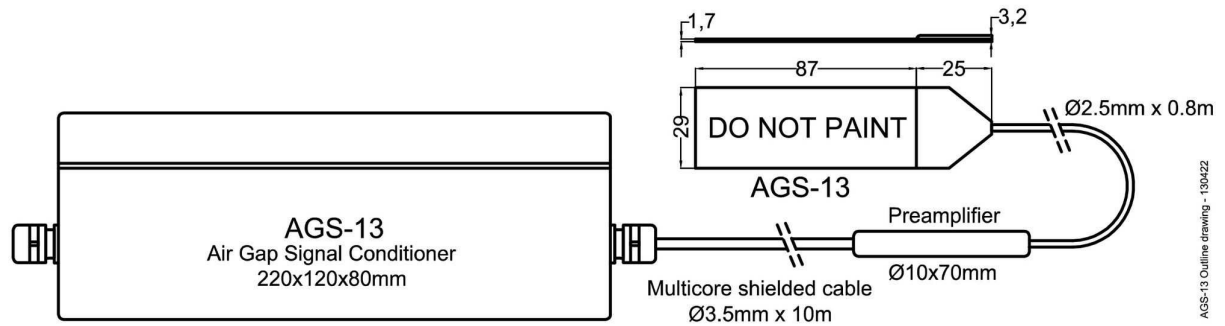


Figure 7. AGS-13 outline drawing

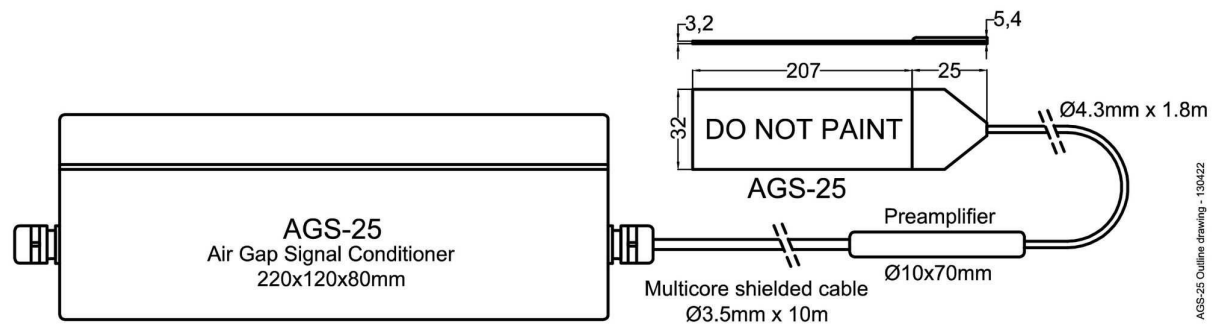


Figure 8. AGS-25 outline drawing

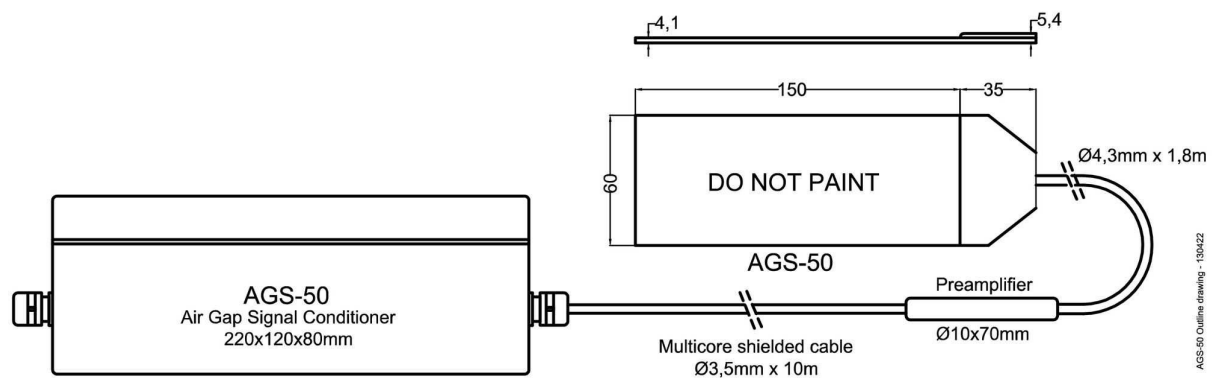


Figure 9. AGS-50 outline drawing

4. Installation instructions

4.1. AGS Signal Conditioner unit installation guide



Figure 10. AGS Signal Conditioner unit

4.2. Appropriate location for AGSC signal conditioner unit

- up to 10 meters from the sensor probe, up to 100 meters from acquisition unit (with 0...20mA loop, if voltage output used, interference free distance may vary),
- prefer well ventilated, dry area free of vibrations and stray magnetic fields,
- ensure adequate ground for enclosure with minimum length of wire,
- ensure access to 24 Vdc / 0,15A Power Supply.

Whenever possible use auxiliary enclosure with door end hinge to additionally shield AGS signal conditioner unit from environmental influences, thermal changes etc.

4.3. Grounding of AGS signal conditioner unit

CAUTION: *Grounding is essential for system operation integrity as well as for protection against hazardous voltages. For best grounding, provide the shortest path possible between the AGS signal conditioner unit and the grounded structure.*

WARNING: *MULTICORE CABLE SHIELD SHALL BE GROUNDED AT ACQUISITION CARD INPUT ONLY. MULTIPLE GROUND POINTS WILL CAUSE NOISE PICK-UP AND CAN DAMAGE CONDITIONER UNIT ELECTRONICS.*

4.4. Power supply connection

Power to AGS signal conditioner unit shall be 24VDC, $\pm 10\%$, 0,15A max. Conditioner unit input has insulated DC-DC converter allowing any pole to be grounded or floating power supply as well as daisy chain of several Conditioner units.

4.5. Calibration

The **AGSP** sensor probe and **AGSC** signal conditioner units are factory matched and calibrated for best performance. However if needed, may be calibrated at site. For details please contact www.mikrotrend.com

4.6. AGSP Sensor probe installation guide

CAUTION: *The AGSP sensor probe shall be handled with care. Do not apply paint or silicone to the sensor surface. Never pull or use excessive force on the sensor cable or preamplifier.*

The sensor surface is treated with high quality insulation varnish, it shall not be scratched as damage to semiconductive electrodes may occur.

4.7. Placing the sensor

Choose position for AGSP sensor probe considering number of sensors and machine poles.

True accurate rotor/stator geometry can be obtained with only one **Rotor mounted Air Gap Sensors**, and four **Stator mounted Air Gap Sensors**.

<http://www.mikrotrend.com/wrm-wireless-hydrogenerator-rotor-monitor.htm>

If **Wireless Rotor AGS** is not used than good practical results are achieved:

-4 sensors per generator for diameters of less than 7,5 meters,

-8 sensors per generators with diameter 7,5... 12 meters

-and 12 to 16 sensors for larger diameters.

Place sensors on the upper side of the stator as it will have higher excentricity than the lower side. For stator height of more than 1,8 meters Air Gap sensors should be placed on the lower side also.

Sensor shall be glued against stator laminations as deep as practical in the air gap or at stator edge if EDGE type of sensor probe is to be used.

In general, this is beneath the second ventilation hole. The preamplifier (small cylinder shape integrated within the cable) **must** stay outside of the air gap and outside of the endwindings, if possible outside of the stator casing.

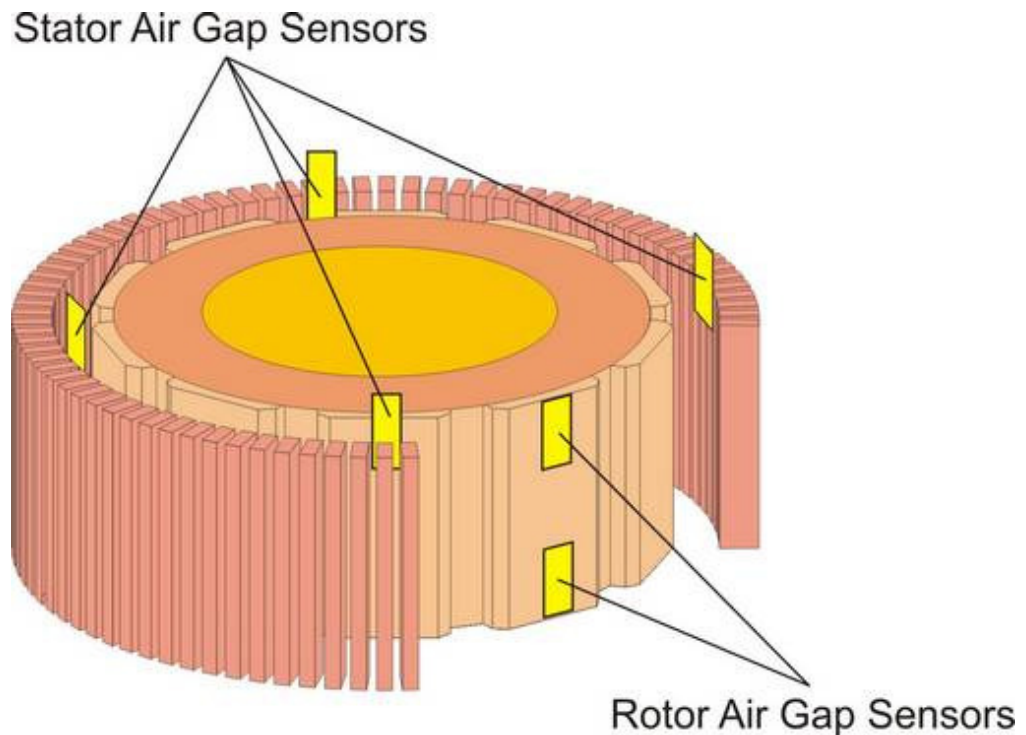


Figure 11. Air Gap Sensor probe positions

4.8. Preparing the stator surface

Thoroughly clean the stator surface, use allowed cleaning liquid such as **isopropanol** alcohol, disposable cotton rags and fine **non-metallic** sandpaper.

WARNING: ***DO NOT USE ACETONE OR OTHER SOLVENTS.***

Use a clean rag moistened with isopropanol over the stator surface to remove oil and carbon deposits.

Epoxy coated or painted stator laminations check for **mechanical stability**. If necessary polish the surface and/or remove unstable particles with **non-metallic** sandpaper.

CAUTION: ***Sensor's bottom surface shall be insulated from stator iron, (a thin coat of adhesive will provide sufficient insulation).***

After sanding, once again clean stator surface with a rag moistened with isopropanol. The glue surface should be flat, without protruding laminations, Slight unevenness can be tolerated ($\pm 0.5\text{mm}$).

Let the isopropanol evaporate at room temperature for about 10minutes before proceeding with glue application.

4.9. Mounting the sensor

The **AGSP** sensor probe shall be aligned with the plane area of the rotor pole. A small missalignment may be compensated with offset adjustment. The sensor measuring surface shall be entirely covered by the pole surface.

We recommend three methods for fastening the sensors, each with different curing times and operating temperatures:

CAUTION: ***Commonly found Epoxy adhesive is not flexible enough. The sensor may come off due to uneven surface tensions during high load periods on generator.***

A. Double sided tape, (150°C):

Double Side adhesive 3M Scotch Acrylic Foam Tape VHB 4611.

With glue thickness of 1mm, a foam type tape will allow stator unevenness of up to 0,3 mm. Allowed temperatures of 149°C (for weeks) and short time up to 230°C (hours).

Clean the back surface of the sensor with a cotton rag moistened with isopropanol. Place double sided adhesive tape on the back side of the sensor. Remove protective foil and carefully place sensor in position without touching adhesive surface. Using protective gloves or a rag press the sensor firmly against the stator surface. Adhesive is pressure sensitive and reacts on the first applied pressure. The sensor can be put in use immediately after gluing, full strength will be reached after 24 hours.

B. Silicone sealant-adhesive, non-acid (neutral), high temperature TEMPFLEX Loctite 5145 (250°C)

Our preferred mounting technique with high flexibility and high holding force. This is only method recommended for **Wireless Rotor AGS** where high G-forces are present. Standard operation temperatures from -85...250 °C up to 300 °C.

A must for locations where stator surface coating has low adhesion to stator laminate. Silicone sealant effectively compensates uneven surface tensions during high load periods on generator thus ensuring stable mounting of the sensor.

With paper adhesive tape, mark border area about 5 mm larger on each side than sensor surface. Apply Silicone sealant about 1mm thick, evenly spread over entire **back surface** of the sensor.

Carefully place sensor within paper covered opening and firmly press until sealant stops coming out.

Wipe of excess sealant with paper towel until clean and remove adhesive paper border.

Fix the sensor in position with adhesive tape (Power-Tape) for at least 6 hours. Full curing times up to 24 h. shorter with higher ambient moisture.

C: Two component glue (short curing time) LOCTITE MULTIBOND 330
continuous operation temperature not exceeding 80°C

If stator laminate coating is strong and stable, You can use two component adhesive type **LOCTITE MULTIBOND 330**. It is quick and simple application, but flexibility is not great and above mentioned precautions about surface stability and operating temperature shall be observed.

When generator is under heavy load and if surface is not stable enough, the sensor may come off due to tensions which adhesive cannot compensate.

Clean the back surface of the sensor with a rag moistened with alcohol.

Follow manufacturers instructions. Curing times will vary with surface temperature, 50% of the final strength is reached after 10...30 minutes, full strength after approx. 5 hours.



Figure 12. AGSP sensor probe installed at stator surface
(pictured left of magnetic field sensor)



Figure 13. Air Gap sensor probe installed at rotor pole

4.10. True Air-Gap and offset

The output of the signal conditioner provides the distance value between **the sensor surface and rotor pole**.

Offset is the distance between the stator surface and sensor surface, including the thickness of the glue:

Offset = glue thickness+sensor thickness, varies with sensor type and mounting method.

True air-gap is sum of measured and offset value.

Offset compensation shall be made at the monitoring system and displayed value will be True air gap distance.

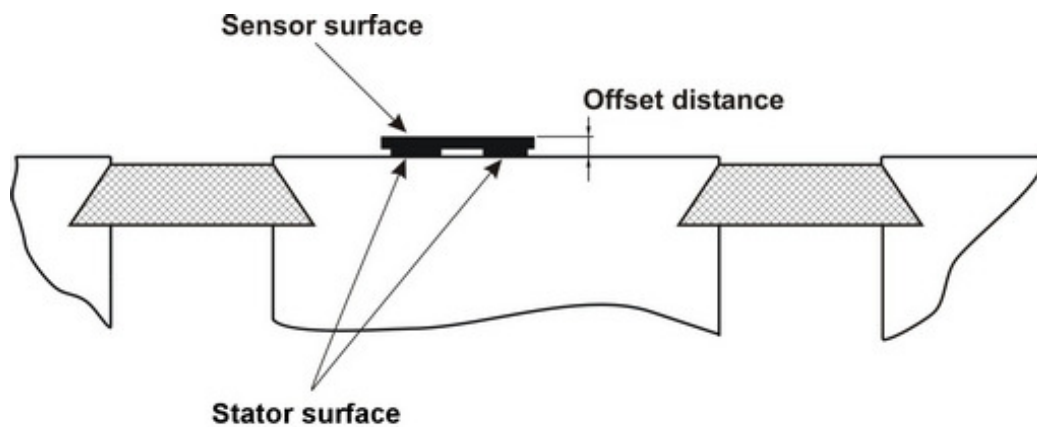


Figure 14. AGS - Offset distance

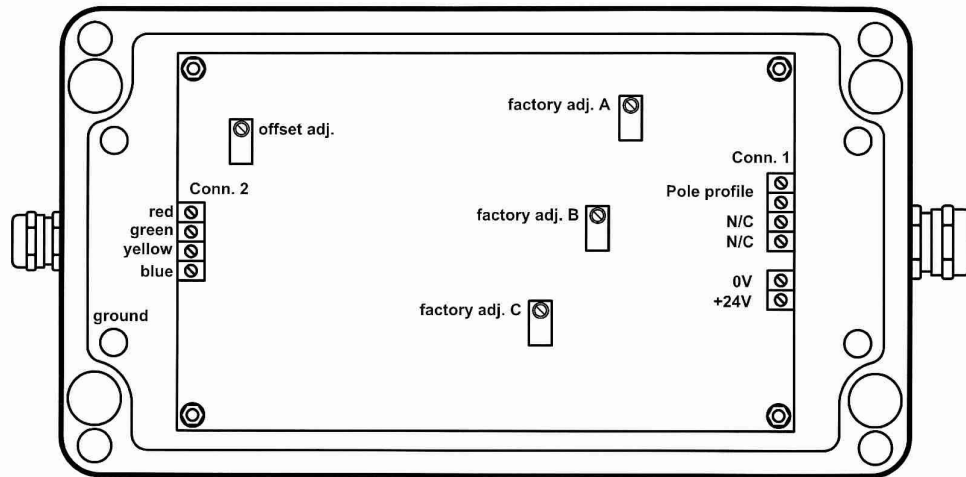


Figure 15. AGSC - signal conditioner adjustments

NOTE: *Before attempting new offset adjustment let AGSC Signal conditioner unit be powered for 20...30 minutes.*

Slowly turn trimmer potentiometer labeled **Offset adj.** until reaching required output current/voltage. Normally, very small rotation will provide large changes on output.

CAUTION: *DO NOT adjust other trimmer potentiometers, (factory adjustment only).*

4.11. Cable installation

WARNING: *Beware of high voltages on the stator bars (5...22 kV). Do not attach triaxial cable directly to the stator bars. The triaxial cable, preamplifier and multicore shielded cable must be protected by a flexible or semi-rigid polyethylene (PVC) conduit.*

CAUTION: *The triaxial cable shall not be modified.*

Muticore shielded cable (between preamplifier and signal conditioner unit) **may be shortened** if necessary.

Gently preshape the triaxial cable by hand to get the right form, avoid to bend it beyond a right angle.

Immobilize the triaxial cable inside the air gap to prevent vibrations and/or mechanical displacement:

- hold the triaxial cable temporary with Cyanoacrylate type glue, point-glued to the stator laminations (iron) surface.

- apply Silicone sealant along the cable in the air gap up to the exit making a strong permanent bond.

The figure illustrates how to connect the multicore cable to the AGSC conditioner unit.

NOTE: When 0...10V output is needed instead of 0...20mA (4...20mA), a current to voltage conversion resistor of 500 ohms should be placed at the end of line near the acquisition unit (lower noise level).



Distance (mm)	Iout (mA)	Vout (V) at 500 Ohm
0	0	0
5	4	2
25	20	10

Distance (mm)	Iout (mA)	Vout (V) at 500 Ohm
0	4	2
5	7,2	3,6
25	20	10

15/17

5. Troubleshooting

Pole profile Output signal higher than 20mA or 10V:

Check the distance to pole surface is within measuring range.

If this happens during replacement of a new sensor slowly turn Offset adjustment trimmer potentiometer (inside Conditioner unit) until reaching desired output.

2. Pole profile Output signal to low:

A. If this happens during **replacement** of a new sensor slowly turn Offset adjustment trimmer potentiometer inside Conditioner unit until reaching desired output.

B. If this happens during **normal working** conditions check Sensor or Triax cable for damages.

3. 50 or 100Hz Noise in pole profile signal:

A. Check grounding scheme. Ground loops shall be avoided.

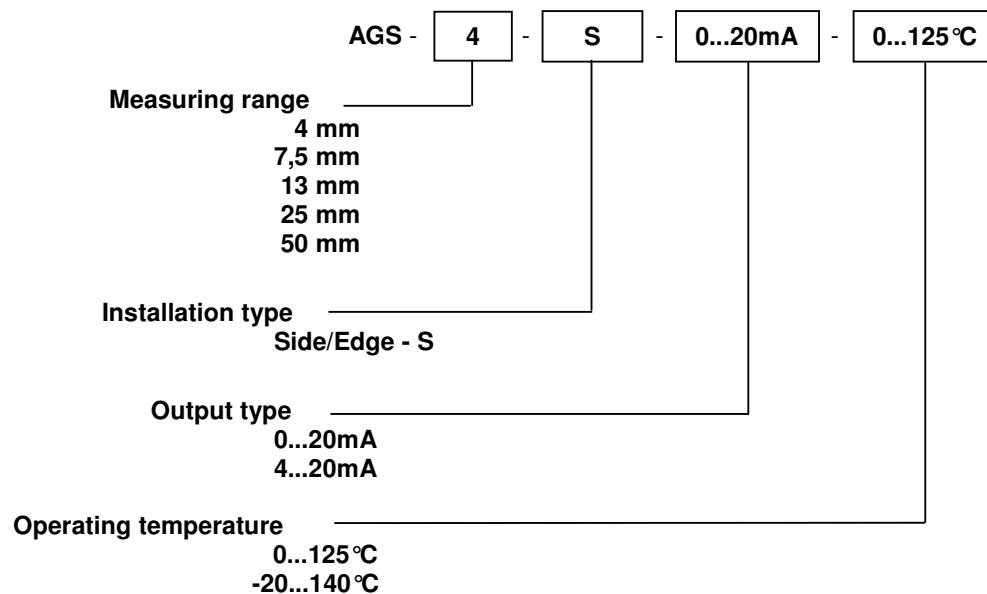
B. AGSC conditioner unit will tolerate approx 0,1 Tesla of stray magnetic fields. If stronger fields are present use additional protection-box made from ferromagnetic material or move to other location.

6. Ordering information

AGS Air Gap Sensor is delivered as factory calibrated sets containing:

- P/N: AGSP sensor probe with integrated preamplifier and connection cable,
- P/N: AGSC signal conditioner.

When ordering please use the following format:



7. Important notice

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